The Impact of the Proposed Nigeria 330KV Integrated Network on the Transfer Capacity of the Existing 330KV Network

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Abstract: The impact of the proposed integrated 330kV network on the transfer capacity of the existing 330kV network is analyzed in this work using ETAP 12.6 and the results analyzed with MATLAB software. The results obtained indicates that the transfer capacity of the entire network is increased by 2GW with the proposed integrated 330kV network. This will eradicate system collapse and more load will be accommodated in the network without stressing the network beyond it thermal limits.

Keywords: Integrated, Grid Network, Transfer Capacity, Voltage collapse, Generation, Transmission.

I. INTRODUCTION

The transfer capacity of a network is the maximum power in megawatt (MW) that can be transferred in the network. For a power system to be operated safely, the maximum power transferred must not exceed the transfer capacity of the network. When this is exceeded, the system experiences high power losses, frequency drop and voltage instability which will result to system load shedding, if not quickly carried out may led to voltage collapse on the entire network. Omorogiuwa and Ike (2014) in their study of Power flow control in the 330KV Integrated power network using unified power controller revealed that the Nigeria power system has a problem of insufficient transmission lines resulting to overloading and stressing of the network beyond their thermal limits as a result of increased load demand.

Ekeh and Evbogbai (2005) in their study of the NEPA Grid system failures in Nigeria revealed that the transmission disturbance contributed about 84.21% of the grid system failure. The report also identify the phase to earth faults as the most common case of the grid system disturbance.

Byung and Kwang (1991) reported that the heart of voltage stability problems occur when there is a voltage drop due to high load demand on the network causing voltage instability that leads to voltage collapse. This voltage collapse occurs when there is an initial slow progressive decline in the voltage magnitude of the power system bus finally rapid decline in the voltage magnitude. Ekeh and Evbogbai (2005) in their work suggested ways for improvement on the reliability of the grid system to include reinforcement of the network and transformer upgrading, routine maintenance culture of transmission equipment, overhauling and repairs of various electric power plants, installation of sophisticated and modern metering supervisory and control equipment at the National Control Centres, building of more generating station and reinforcement of grid system through dualization of single circuit. Abdullah (2009) in his work, stated that acceptable reliability level of power system requires additional generating capacity to meet the expected increase in future electrical load demands. The rapid increase in the demand for electricity is as a result of population growth, industrial expansion and increase in customer's appliances which have necessitated the stepping up of generation and transmission capacities of the grid network to deliver quality power supply. Onojo, Ononiwu and Okozi (2013) research shows that the existing grid networks is inadequate and lack the capacity to provide the quality and quantity of power for the country. This work present the impact of the proposed Nigeria 330kV integrated network on the transfer capacity of the existing 330kV network.

II. MATERIALS AND METHOD

The materials utilized in the analysis of this work include; ETAP 12.6 software, the Existing 330KV grid network, the Proposed 330KV grid network and MATLAB software for the analysis of results obtained.

In this work, the Existing 330KV and proposed integrated 330KV network of the Nigeria National grid were modelled in ETAP 12.6 environment as shown in figure 1 and figure 2 respectively.

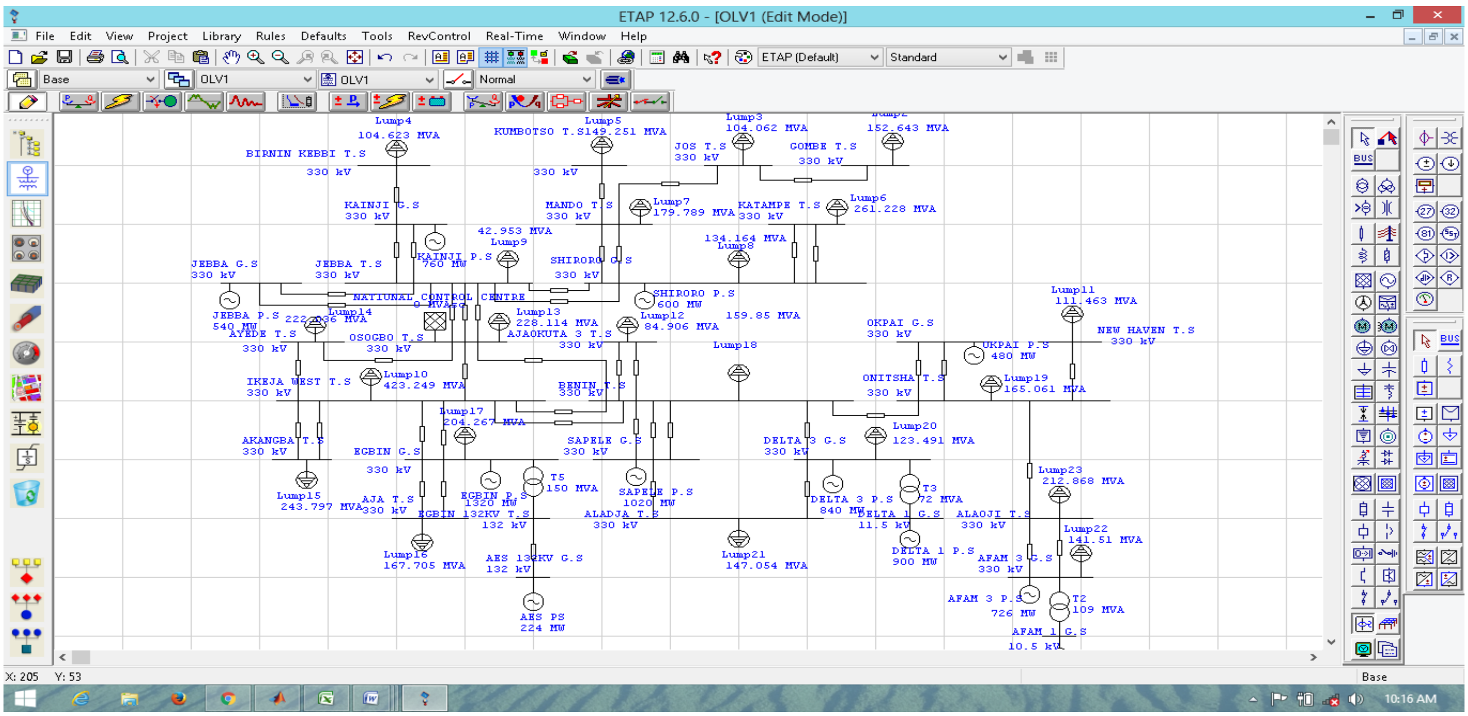

Figure 1: Model of Existing 330KV Network using ETAP 12.6 Software

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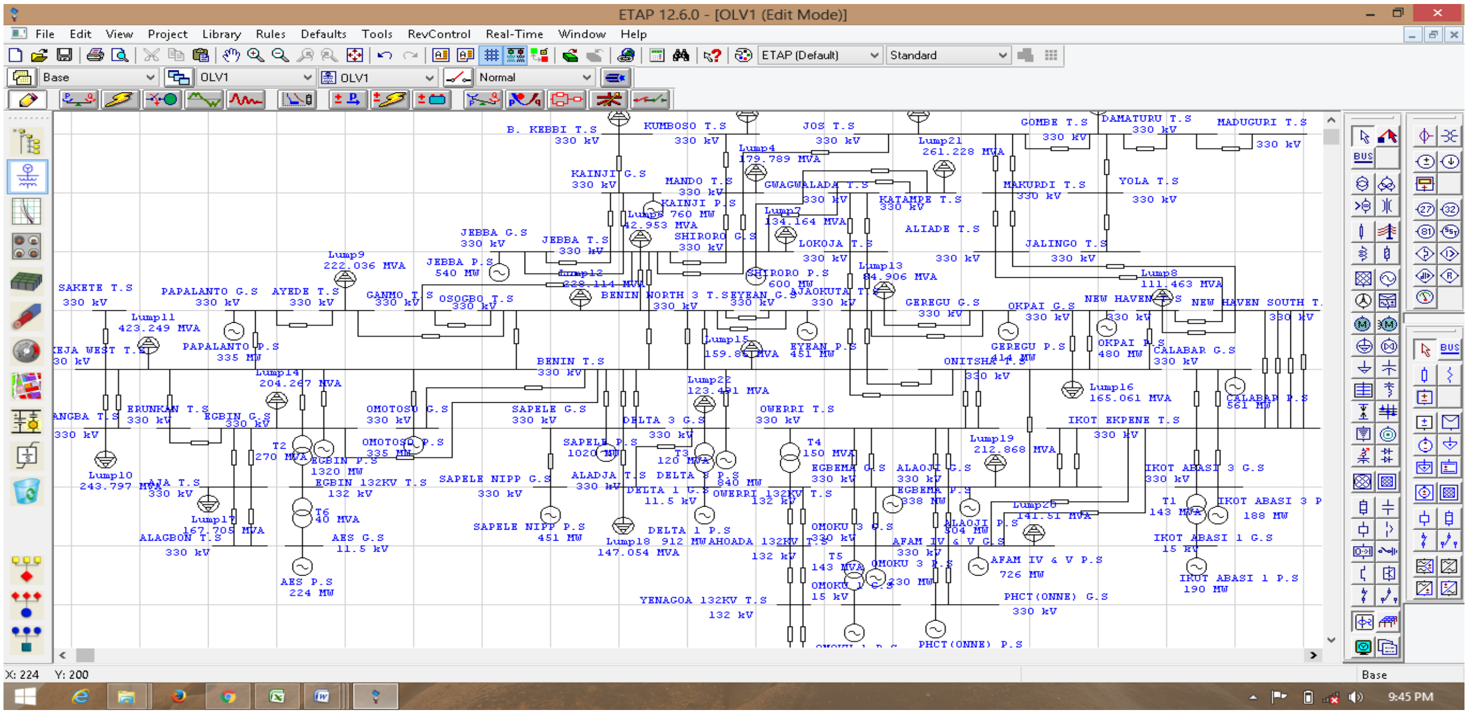

Figure 2: Model of Proposed Integrated 330KV Network using ETAP 12.6 Software

These models were simulated (run mode) in the same environment using Newton Raphson Iteration Algorithm with a precision of 0.0001 as a result of it easy convergence as shown in figure 3 and figure 4.

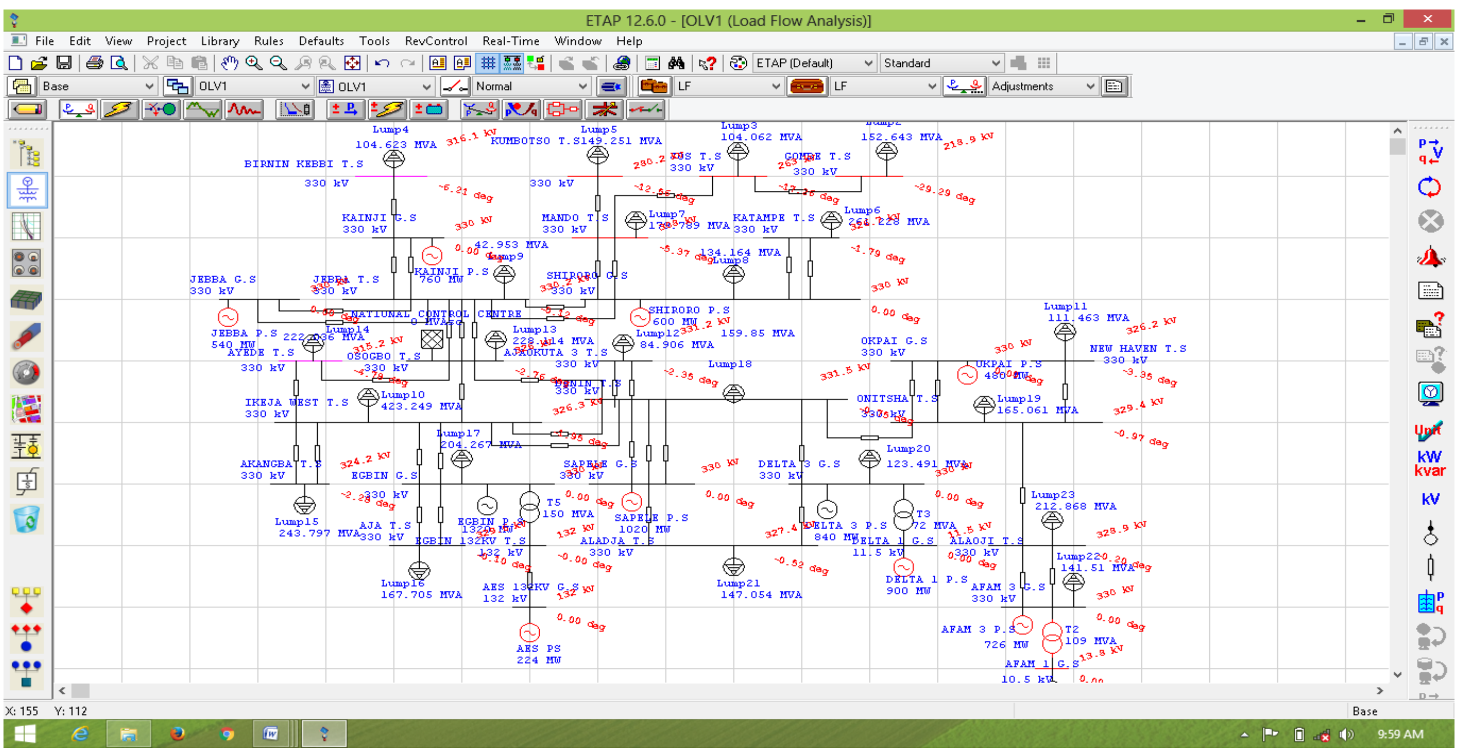

Figure 3: Simulation (Run Mode) of Existing 330KV Network using ETAP 12.6 Software

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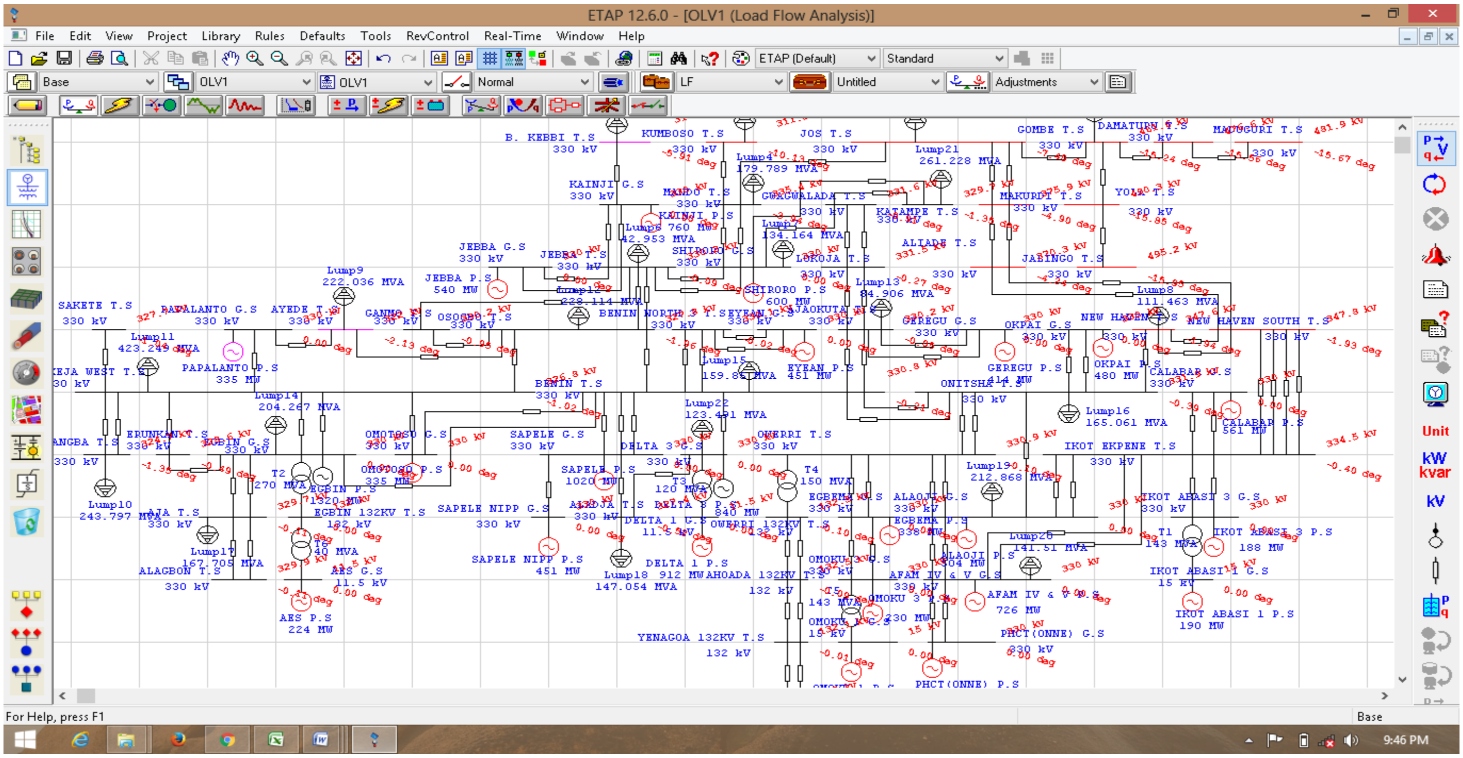

Figure 4: Simulation (Run mode) of Proposed Integrated 330KV Network using ETAP 12.6 Software

III. RESULT AND DISCUSSION

The simulated and calculated value of the transfer capacity of both the existing 330KV and proposed integrated 330KV network is tabulated in table 1 and table 2 with their respective graphs obtained from MATLAB.

Table 1: Transfer Capacity of the Existing 330KV Network

Transmission Lines (330KV)	From Bus	To Bus	Simulated Transfer Capacity of the lines from Power Flow Result (MW)	Calculated value of Maximum Power Transferred on each lines (MW)
1	GOMBE T.S	JOS T.S	122.06	75.03
2	KUMBOTSO T.S	MANDO T.S	118.97	65.12
3	BIRNIN KEBBI T.S	KAINJI G.S	87.54	87.77
4	KAINJI G.S	JEBBA T.S	5.95	22.93
5	KAINJI G.S	JEBBA T.S	5.95	22.93
6	MANDO T.S	SHIRORO G.S	256.78	27.18

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7	JOS T.S	MANDO T.S	223.85	55.78
8	KATAMPE T.S	SHIRORO G.S	117.53	86.25
9	JEBBA T.S	JEBBA G.S	125.37	4.79
10	JEBBA T.S	JEBBA G.S	125.37	4.79
11	JEBBA T.S	SHIRORO G.S	1.98	69.09
12	JEBBA T.S	SHIRORO G.S	1.98	69.09
13	JEBBA T.S	OSOGBO T.S	75.21	44.45
14	JEBBA T.S	OSOGBO T.S	75.21	44.45
15	NEW HAVEN T.S	ONITSHA T.S	109.49	27.18
16	OKPAI G.S	ONITSHA T.S	112.07	47.92
17	OKPAI G.S	ONITSHA T.S	112.07	47.92
18	AJAOKUTA 3 T.S	BENIN T.S	36.23	55.21
19	AJAOKUTA 3 T.S	BENIN T.S	36.27	55.21
20	BENIN T.S	OSOGBO T.S	37.19	71.07
21	OSOGBO T.S	AYEDE T.S	82.79	32.56
22	OSOGBO T.S	IKEJA WEST T.S	13.9	71.35
23	IKEJA WEST T.S	AKANGBA T.S	93.84	5.10
24	IKEJA WEST T.S	AKANGBA T.S	93.84	5.10
25	EGBIN G.S	AJA T.S	74.96	8.39
26	EGBIN G.S	AJA T.S	74.96	8.39
27	IKEJA WEST T.S	EGBIN G.S	296.12	37.13
28	IKEJA WEST T.S	EGBIN G.S	296.12	37.13
29	BENIN T.S	SAPELE G.S	61.12	14.16
30	BENIN T.S	SAPELE G.S	61.12	14.16
31	BENIN T.S	SAPELE G.S	61.12	14.16
32	SAPELE G.S	ALADJA T.S	40.3	17.84
33	DELTA 3 G.S	ALADJA T.S	79.33	9.06
34	BENIN T.S	DELTA 3 G.S	28.56	30.30
35	ONITSHA T.S	BENIN T.S	9.18	38.79
36	ONITSHA T.S	BENIN T.S	9.18	38.79
37	AJAOKUTA 3 T.S	BENIN T.S	36.23	55.21
38	ONITSHA T.S	ALAOJI T.S	23.61	39.07

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			3223.35	1460.85

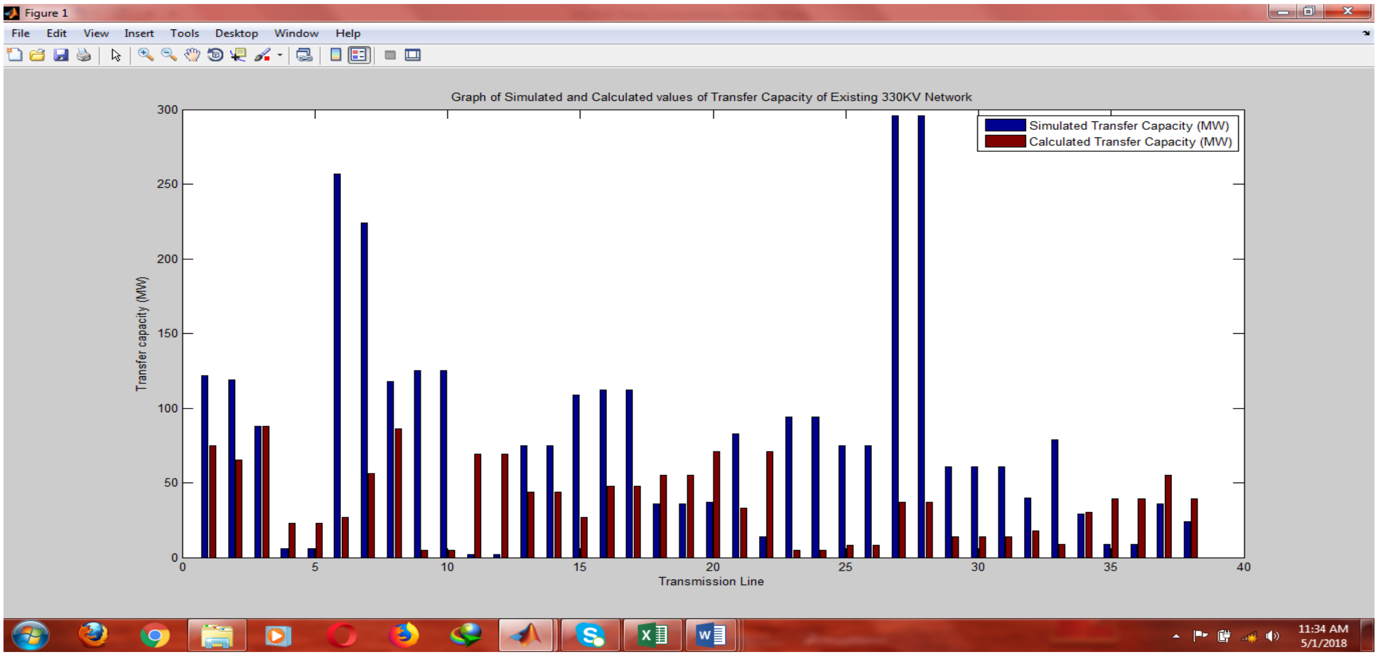

Figure 5: Graph of Simulated and Calculated values of the Transfer Capacity of the Existing 330KV Network.

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Table 2: Transfer Capacity of the Proposed Integrated 330KV Network

Transmission Lines (330KV)	From Bus	To Bus	Simulated Transfer Capacity of the lines from Power Flow Result (MW)	Calculated value of Maximum Power Transferred on each lines (MW)
1	GOMBE T.S	JOS T.S	170.121	75.03
2	DAMATURU T.S	GOMBE T.S	0.755	38.22
3	MADUGURI T.S	DAMATURU T.S	0.081	39.64
4	KUMBOSO T.S	MANDO T.S	123.223	65.12
5	B. KEBBI T.S	KAINJI G.S	83.653	87.77
6	KAINJI G.S	JEBBA T.S	4.455	22.93
7	KAINJI G.S	JEBBA T.S	4.455	22.93
8	MANDO T.S	SHIRORO G.S	173.974	27.18
9	MANDO T.S	SHIRORO G.S	173.974	27.18
10	MAKURDI T.S	ALIADE T.S	115.528	29.95
11	MAKURDI T.S	ALIADE T.S	115.528	29.95
12	YOLA T.S	JALINGO T.S	0.071	37.37
13	JOS T.S	MANDO T.S	56.1	55.78
14	KATAMPE T.S	GWAGWALADA T.S	150.996	8.49
15	KATAMPE T.S	SHIRORO G.S	85.277	86.25
16	GWAGWALADA T.S	SHIRORO G.S	68.41	68.28
17	GWAGWALADA T.S	LOKOJA T.S	41.637	83.85
18	GWAGWALADA T.S	LOKOJA T.S	41.637	83.85
19	JOS T.S	MAKURDI T.S	114.681	137.76
20	JOS T.S	MAKURDI T.S	114.681	137.76
21	GOMBE T.S	YOLA T.S	1.609	61.44
22	JEBBA T.S	JEBBA G.S	93.659	4.79
23	JEBBA T.S	JEBBA G.S	93.659	4.79
24	SHIRORO G.S	JEBBA T.S	1.479	69.09
25	SHIRORO G.S	JEBBA T.S	1.479	69.09
26	JEBBA T.S	OSOGBO T.S	53.002	44.45
27	JEBBA T.S	OSOGBO T.S	53.002	44.45
28	JEBBA T.S	GANMO T.S	53.492	19.82
29	LOKOJA T.S	AJAOKUTA T.S	41.708	22.76
30	LOKOJA T.S	AJAOKUTA T.S	41.708	22.76
31	ALIADE T.S	NEW HAVEN SOUTH T.S	119.649	89.84
32	NEW HAVEN SOUTH T.S	ALIADE T.S	119.649	89.84
33	NEW HAVEN SOUTH T.S	NEW HAVEN T.S	30.439	2.99
34	NEW HAVEN	NEW HAVEN	30.439	2.99

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	SOUTH T.S	T.S		
35	NEW HAVEN T.S	ONITSHA T.S	52.881	27.18
36	CALABAR G.S	IKOT EKPENE T.S	33.232	42.12
37	CALABAR G.S	IKOT EKPENE T.S	33.232	42.12
38	NEW HAVEN SOUTH T.S	IKOT EKPENE T.S	76.632	85.65
39	NEW HAVEN SOUTH T.S	IKOT EKPENE T.S	76.632	85.65
40	NEW HAVEN SOUTH T.S	IKOT EKPENE T.S	76.632	85.65
41	NEW HAVEN SOUTH T.S	IKOT EKPENE T.S	76.632	85.65
42	SAKETE T.S	IKEJA WEST T.S	0.005	19.82
43	PAPALANTO G.S	IKEJA WEST T.S	158.38	8.49
44	AYEDE T.S	PAPALANTO G.S	165.827	16.99
45	OKPAI G.S	ONITSHA T.S	37.849	47.92
46	OKPAI G.S	ONITSHA T.S	37.849	47.92
47	GEREGU G.S	AJAOKUTA T.S	80.84	29.95
48	GEREGU G.S	AJAOKUTA T.S	80.84	29.95
49	AJAOKUTA T.S	BENIN T.S	3.1	55.21
50	AJAOKUTA T.S	BENIN T.S	3.1	55.21
51	EYEAN G.S	BENIN NORTH 3 T.S	35.684	2.99
52	EYEAN G.S	BENIN NORTH 3 T.S	35.684	2.99
53	BENIN NORTH 3 T.S	BENIN T.S	35.68	5.66
54	BENIN NORTH 3 T.S	BENIN T.S	35.68	5.66
55	OSOGBO T.S	BENIN T.S	31.483	71.07
56	OSOGBO T.S	GANMO T.S	53.177	24.63
57	OSOGBO T.S	AYEDE T.S	12.452	32.56
58	OSOGBO T.S	IKEJA WEST T.S	15.444	71.35
59	IKOT EKPENE T.S	IKOT ABASI 3 G.S	31.903	44.92
60	IKOT EKPENE T.S	IKOT ABASI 3 G.S	31.903	44.92
61	IKEJA WEST T.S	AKANGBA T.S	93.897	5.1
62	IKEJA WEST T.S	AKANGBA T.S	93.897	5.1
63	IKEJA WEST T.S	ERUNKAN T.S	76.673	9.06
64	EGBIN G.S	ERUNKAN T.S	76.822	8.49
65	EGBIN G.S	AJA T.S	74.976	8.39
66	EGBIN G.S	AJA T.S	74.976	8.39
67	AJA T.S	ALAGBON T.S	0.001	7.36
68	AJA T.S	ALAGBON T.S	0.001	7.36
69	IKEJA WEST T.S	EGBIN G.S	160.691	37.13
70	IKEJA WEST T.S	EGBIN G.S	160.691	37.13
71	IKEJA WEST T.S	OMOTOSO G.S	29.696	45.3
72	BENIN T.S	OMOTOSO G.S	6.666	33.98
73	BENIN T.S	EGBIN G.S	3.669	61.72
74	BENIN T.S	SAPELE G.S	33.137	14.16

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75	BENIN T.S	SAPELE G.S	33.137	14.16
76	BENIN T.S	SAPELE G.S	15.997	14.16
77	SAPELE G.S	ALADJA T.S	40.296	17.84
78	DELTA 3 G.S	ALADJA T.S	79.333	9.06
79	BENIN T.S	DELTA 3 G.S	7.475	30.3
80	ONITSHA T.S	BENIN T.S	4.843	38.79
81	ONITSHA T.S	BENIN T.S	4.843	38.79
82	ONITSHA T.S	OWERRI T.S	31.896	44.92
83	ONITSHA T.S	OWERRI T.S	31.896	44.92
84	OWERRI T.S	EGBEMA G.S	21.284	8.49
85	OWERRI T.S	EGBEMA G.S	21.284	8.49
86	ONITSHA T.S	ALAOJI G.S	50.465	16.99
87	OWERRI T.S	ALAOJI G.S	10.642	16.99
88	OWERRI T.S	ALAOJI G.S	10.642	16.99
89	IKOT EKPENE T.S	ALAOJI G.S	62.965	22.76
90	IKOT EKPENE T.S	ALAOJI G.S	62.965	22.76
91	IKOT EKPENE T.S	AFAM IV & V G.S	26.585	53.91
92	AFAM IV & V G.S	IKOT EKPENE T.S	26.585	53.91
			5115.889	3549.52

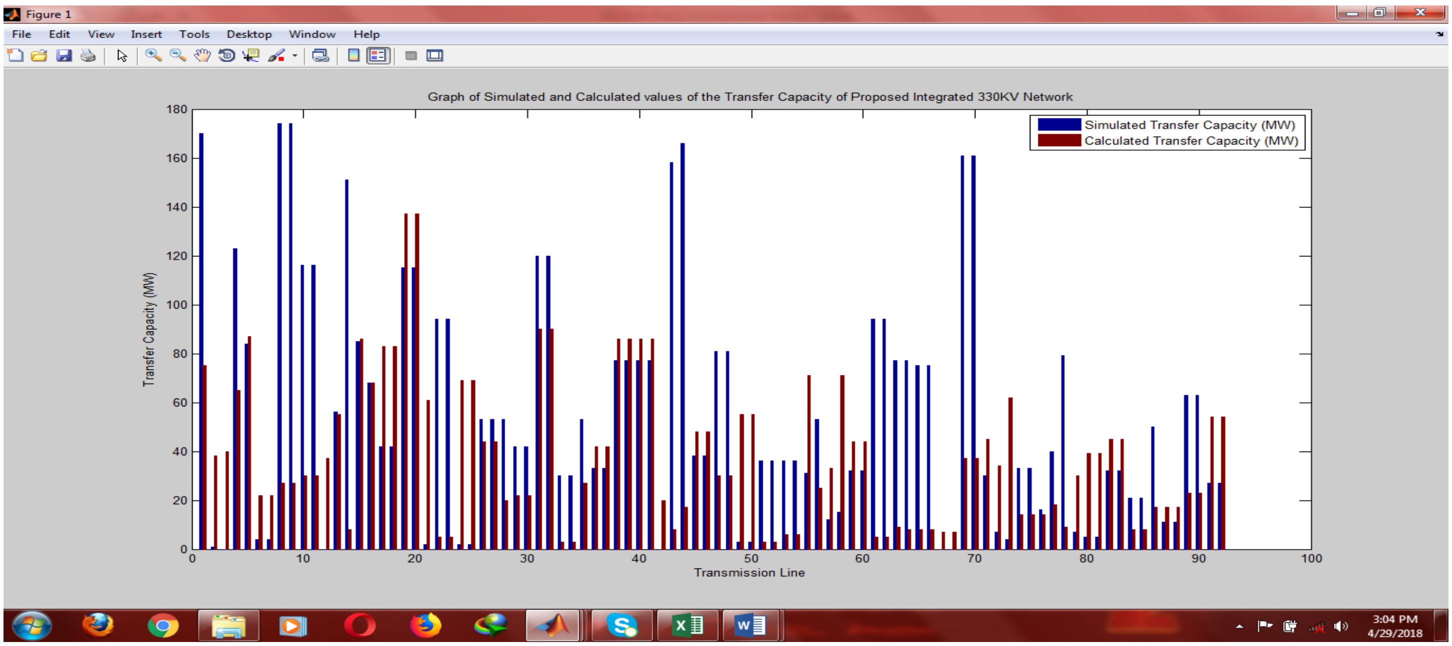

Figure 6: Graph of Simulated and Calculated values of the Transfer Capacity of the Proposed Integrated 330KV Network

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Table 3: Summary of Simulated and Calculated Transfer Capacity of Existing 330KV network and Proposed Integrated 330KV network

Network Type	Simulated Transfer Capacity (MW)	Calculated Transfer Capacity (MW)
Proposed Integrated 330KV Network	5,115.89	3,549.52
Existing 330KV Network	3,223.35	1,460.85
Difference	1,892.54	2,088.67

From the analysis in table 3, the transfer capacity of the existing 330KV network is improved by approximately 2GW either by simulation or by calculation

IV. CONCLUSION

The study reveal that the transfer capacity of the entire network is increased by 2GW with the proposed integrated 330KV network. This will help the system to accommodate more load and reduce load shedding drastically and also eradicate system collapses in the network as result of voltage instability.

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